be distributed, so new knowledge has to be gained before it can be applied. The political party which concentrates attention upon inequalities in the distribution of wealth, and neglects to take its production into consideration, presents the same attitude to progress as does the industrialist whose outlook is limited by what he can observe now, and who sees no profit in the extension of it by research. Yet a slight knowledge of modern social and industrial history would be sufficient to convince the most indifferent mind that pure and applied science is the life-blood of a nation in these times. But for this we could not have existed during the past century. After the Napoleonic wars this country was left in much the same difficult and troublous condition that it finds itself in to-day. Then, as now, we came out of the conflict with our soil inviolate, but were faced with widespread social and industrial unrest, due partly to the avarice of landowners and manufacturers, and partly to the ruin of village industries by the use of mechanical power in factories. We were saved from financial disaster at that time by increased output due to the invention of the steam engine, by which mines were freed from water, and coal, iron, and copper were rendered abundantly available. Textile trades were provided with the means for great expansion by the use of factory machinery in connection with the inventions belonging to them, and the advent of the railway and the steamship created further demands for iron and steel, and the coal necessary for their production. Thus it was that, while there was almost constant unrest in every European State, and heavy taxation had produced a condition approaching semi-starvation over a large part of the country, we were able to maintain our credit.

The country was then saved by invention, and we should have maintained the same lead in the chemical and electrical industries if our manufacturers had been alive to the practical value of scientific research, or our politicians had stimulated enterprises associated with its application instead of strangling them with unnecessary legislation. The thing to remember is that, whether we like it or not, we must advance if we are not to be left behind other progressive nations. The only way to keep in the van of modern industrial forces is to provide what other people want which they cannot produce for themselves either so cheaply or so excellently as we can. In view of international competition, it is not possible, in the neutral and open markets of the world, to increase the selling price of goods which can be produced by other nations unless they are decidedly superior in quality. Craftsmanship counts for something in securing this superiority, but the richest promise in these days lies in the discovery of new knowledge by research and the application of it to industry.

The output of British scientific workers is to-day larger than ever it was, and if industrial development does not proceed from it, the fault will not lie at their doors. Neither can they be blamed if social conditions are not improved by the increase of national wealth through the use of science. Their function is to discover, and faithfully they are performing it; it is for statesmen to see that this creative work is given every encouragement, for manufacturers to make profitable use of it, and for social reformers to ensure that the fruits are used to promote national well-being. Only thus can we make progress and in the future avoid the reproach that science necessarily signifies the desecration of Nature, and the degrading social conditions of the factory towns brought into existence by its users a century ago.

Matter and Motion.

Matter and Motion. By the late Prof. J. Clerk Maxwell. Reprinted with notes and appendices by Sir Joseph Larmor. Pp. xv+163. (London: S.P.C.K.; New York: The Macmillan Co., 1920.) 5*s*. net.

IN a recent article a well-known musical critic has remarked with perfect truth of musicians—and the same is undoubtedly true of other classes of intellectualists, including men of science—that a man is immune from criticism if by popular acclaim, or in some other way, he has been provided with a halo! If he has such a decoration it is a part of him; he cannot appear without it—whatever he does is right; all his sayings, whether or not they are couched in pure and pellucid English without fault or flaw of expression, are accepted without cavil or question. If an adventurous critic dares to moot some opposing view, it is suggested with the greatest deference and profound apology.

The mode in which this glittering, or rather glistening, appendage is obtained is sometimes obvious enough; at other times it is obscure and mysterious. The recipient may be silently and unanimously received in recognition of his merits into the ranks of the great ones, of course without any ceremony of canonisation, for in science there is no official pontiff. In some other cases of a lower grade of sainthood he is received as the more equivocal result of the applause of a crowd of allies and sympathisers, members perhaps of the same university, pupils and admirers, supporters of all kinds. As a rule, a halo-wearer can do no wrong. This royal prerogative is sometimes mildly disputed, but the disputer generally gets the worst of the discussion, and, unless he is pachydermatous, is duly sorry for himself.

One of the most reverenced of halo-wearers is Clerk Maxwell, who holds his great place by patent given from the highest source of all such dignity. In his writings originality of thought was accompanied always by felicity of phrase and expression, tempered with a savour of wit which is found only in men of subtle and penetrating humour, that wit which is, above all things, a saving grace in literature, and especially in science. Read his address "On the Mirror Galvanometer," supposed to be delivered to a pupil in an alcove with drawn curtains; in spite of the somewhat unpromising subject, it is as good as—nay, some would say it is much better than—its prototype, "The Splendour Falls on Castle Walls," or, indeed, almost any other lyric in Tennyson's "Princess."

From time to time Clerk Maxwell wrote on elementary science in a way which attracted the attention and enchained the admiration of everyone. The first of these writings was "The Theory of Heat"; the second, published in 1877, was "Matter and Motion." Both were unique. In various respects—*e.g.* in the question of entropy—the book on heat was open to objection, but as a presentation of thermodynamic theory it was, and has remained, unrivalled. We prefer the thermodynamic relations in the form which they take when the steps of temperature, pressure, volume, etc., are infinitesimal, and the notation (easily explained and understood) of infinitesimals is used; but this is a detail of no great importance. Nothing could exceed the elegance of the discussion, the importance of the semi-graphical, semi-analytical treatment of the energetics of the subject, and the theme of available energy.

In "Matter and Motion" the subject was really Newtonian dynamics, a theme which, in spite ot the silly exaltations by the popular Press of Einstein above Newton, still remains supreme in dynamics. The first edition had poor and exasperating diagrams, and was not well printed; the present edition has been issued under the editorship of Sir Joseph Larmor, who has given the work everywhere, and in all details, the utmost care and attention. When we consider that the reprint of the original edition is contained in the small compass of 136 of the new pages, it appears marvellous that a view of dynamics so complete in itself in many respects could be compressed into so few pages of print.

On various interesting topics, such as Gravitation and Light and "The Principle of Least Action," Sir Joseph Larmor has added appendices, while he has inserted as chap. ix. a discussion of "The Equations of Motion of a Connected System," which increases the size of the book by only thirty-nine of the present pages. Needless to say, these additions are models of condensation, and at the same time of absolute clearness and accuracy. The new view of the gravitational field, which Einstein's theory of space and time affords, leads to an explanation of an outstanding discrepancy of observation with theory in the motion of the planet Mercury. This involves a certain warping of the reference frame which must be set up for these motions, and this has been verified by the observations of the solar eclipse of 1919, by the fact that rays of light passing near the sun have been found to be deflected by a certain amount predicted beforehand towards that luminary.

It is difficult also to pick out what were the peculiarly interesting parts of Clerk Maxwell's "Matter and Motion." Every bit of it was distinctive and distinguished, but in some ways the discussion of the hodograph, and the question of absolute velocity of rotation, impressed us most. The chapter on the latter subject was read again and again and pondered continually. There came afterwards the discussions by Love and Mach, which, however rigidly logical and silencing, seemed to us far from convincing. Mach's book was no doubt very valuable, but the touch of the writer, if precise, seemed to lack lightness and, as compared with Maxwell's, that distinction which the magic of genius alone can confer. One might weary of Mach's excellent treatise; of Maxwell one never tired.

It is now possible to make a wider survey of the whole subject. The elegance of the hodographic theory appears very vividly in Maxwell's treatment. It is a great thing to say, but there is scarcely anything among the numerous discoveries of Hamilton in dynamics which so signally illustrates his penetrating genius. The hodograph was hit upon some four or five years before Hamilton by Möbius, as may be verified by consulting his treatise on physical astronomy, "Die Mechanik des Himmels." But application of the idea Möbius makes little or none. With Hamilton the applications are everything; the idea is used to obtain all kinds of beautiful results. That Möbius had anticipated him Hamilton was fully aware, and acknowledges (see the Life by Graves) that Möbius might have claimed the notion; but the claim would have been a barren one.

One thing we miss in Maxwell's discussion—that is, the curious theorem of the splitting of the velocity of the particle describing the orbit into two constant components, one at right angles to the radius vector, and the other perpendicular to the major axis of the orbit. It is curious that there should be this relation.

A propos of the principle of least action, discussed in appendix ii., it is remarkable that if the major axis of an elliptic orbit, for a particle moving, as in the case of Nature, under a force along the radius vector from a focus, and varying as the square of the distance, is given, the action (the space-integral of the momentum round the orbit) is independent of the eccentricity of the orbit. It depends only on the major axis, so that it is the same for a circular orbit as for a long, narrow one. This gives a means of solving various problems.

Connected with this is another theorem that the kinetic energy of the particle at distance r from the same centre of force, in a hyperbolic orbit of semi-transverse axis a (equal to the semi-major axis of the elliptic orbit), exceeds, and in the elliptic orbit falls short of, the expansion $m\mu/r$ of potential energy, from infinity to the distance r, by the time or average of the kinetic energy of the elliptic motion.

One thing we cannot understand in the popular treatment of hodographic theory: Why is it always regarded as an affair of particle dynamics only? If we set up, or imagine set up, a sequence of vectors representing the angular momentum of a rigid body, say that of an aeroplane, the velocity of the extremity of the vector is in magnitude and direction the rate of change of the angular momentum. This might help to prevent that pernicious "ignoration" of the direction of the angular momentum vector, and its variation, which characterises so many uninstructed but apparently influential people.

A. GRAY.

A Socialist Commonwealth.

A Constitution for the Socialist Commonwealth of Great Britain. By Sidney and Beatrice Webb. Pp. xviii + 364. (London: Longmans, Green, and Co., 1920.) 12*s.* 6*d.* net.

IN this volume Mr. and Mrs. Webb set themselves to build "an efficiently working, genuinely democratic constitution" out of the materials that are already to hand. The distinctive feature of the Socialist Commonwealth of Great Britain will be the division of the labours of our present overworked Parliament between two co-equal bodies, the Social and the Political Parliaments, both elected on a geographical basis by all the adult citizens. The Political Parliament will deal mainly with defence, justice, and foreign affairs, and will have a keen eye to the protection of the liberty of the individual. To the Social Parliament all else falls—labour, health, education, the control of industry, and care for the interests of generations yet unborn. In the hands of the Social Parliament rests also the power of the purse; from which it may be anticipated that the Political Parliament, for all its nominal equality, will have to mind its "p's and q's."

Perhaps the most fruitful part of a very suggestive work is contained in the proposals for the reconstruction of local government. On this the authors speak with ripe experience of actual administration, as well as with their usual wide theoretical knowledge. The unit of local government is to be the ward, though different wards are to be grouped and re-grouped in such a way as to give a unit of appropriate size for the conduct of each municipalised service. Economic efficiency will thus no longer be subservient to the historical accident of municipal boundaries.

Industry will of course be "socialised." Socialisation will take a variety of forms, the common features of which will be production for use and not for profit, and the separation of control from actual administration. Nationalisation, municipalisation (of which a great expansion is anticipated), and organisation on the co-operative principle exhibited by the existing Consumers' Co-operative Movement will be the three great types. The nationalised industries will be administered by a hierarchy of national boards, regional councils, and works or pit committees, responsible to a Standing Committee of the Social Parliament, and goaded into efficiency by the supervision and control of an independent department. Bureaucracy is anathema. A limited share in administration will be accorded to the appropriate organisations of workers, although Mr. and Mrs. Webb believe in the conduct of industry by the community for the community, rather than by the workers for the workers. The charwomen who clean the schools are not to dictate what shall be taught there. Vocational organisations, of the form of our present trade unions and professional associations, will be concerned rather with the protection of the status of the several vocations, the promotion of all kinds of scientific research (on which the authors lay great stress), and the maintenance of professional honour. For a national body elected on a vocational basis, such as a regenerated Trade Union Congress, the authors